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Study on molecular structure of diatoms frustule by synchrotron X-ray Diffraction and Infrared spectroscopy

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1.INTRODUCTION

The diatoms in ocean, a lake, and a river are responsible for almost a quarter of the photosynthesis of the whole earth (Nelson, et al. 1995). They have a great influence on the element movement of the Earth's surface by absorbing different metal ions selectively (Morel and Price 2003). The diatoms with complicated surface structure have a property to adsorb various substances to their frustules, but the adsorption characteristic depends on the structures of the frustule surface. Furthermore, whether perished diatoms' frustules are stored or not is determined by the structures of the frustules. However, the surface structures of the diatoms' frustules are still unknown very well. Kamatani (1974) researched on the structure of the diatom's frustules by Infrared spectroscopic analysis, but the author didn't separately analyze the collected samples. Recently, Gelabert et al. (2004) classified every species of diatom and studied the structure of the frustules by using the small angle scattering method and Infrared spectroscopic analysis. Because the frustules would be heavily damaged by their samples treatment process, the results of the study have little credibility. This study is aimed to elucidate the molecular structures using Infrared spectroscopic analyses and X-ray diffraction analysis for the diatom's frustules which were collected and cultivated separately in the laboratory.

2. MATERIALS AND METHODS

1) Collection and cultivation processes of diatoms

Diatoms were collected from three sites in Lake Yogo, Siga prefecture, Japan, and in Obitsu River tideland, Chiba prefecture, Japan, and at the northern part of Thailand. They were cultured in nutrient medium f/2 and harvested under red and green LED light at 25 degree C. After multiplying moderately, each species of diatom was carefully transferred into separate Petri dishes and multiplied under a same condition. As a result, 19 species of diatom were isolated and finally three species were successfully obtained in enough quantity for the following experiments.

2) Sample treatments

The each diatom multiplied was filtered through a membrane filter and removed from salts and organic matters by centrifugal separation. After rinsed with acetone, the diatom's frustules were dried at 50 degree C in an oven for three days.

3) The measurement

The synchrotron radiation X-ray diffraction analysis was performed at High Energy Accelerator Research Organization(KEK), Photon Factory(PF), beam line BL8B.

3. RESULT AND DISCUSSION

Gomphonema sp. in the northern part of Thailand, and Nitzschia cf. Frustrum in the Lake Yogo, Siga prefecture form a wedge shape and a spindle shape, respectively. Cylindrotheca sp. in Obitsu River tideland has a long extended needle shape. The form is characterized by the twisted spindle shape composed of thinly frustules. The SEM observation showed that the Gomphonema sp. and Nitzschia cf. Frustrum maintained their forms during the sample treatment. With centrifugal separation, on the other hand, most of the forms of Cylindorotheca sp. were destroyed expect the spiculums at the both ends, maintained. Synchrotron radiation X-ray diffraction analysis showed that Gomphonema sp. and Nitzschia cf. Frustrum gave basically similar broad diffraction pattern to that of amorphous silica. However, Cylndorotheca sp. , unlike other two species, showed sharp peaks at the position of d = 3.920, 2.603, 1.545A and a few weak peaks. The results of the Infrared spectroscopic analysis on Gomphonema sp. and Nitzchia cf. Frustrum showed that the absorption spectra were similar to those of amorphous silica, which is consistent with the result of the X-ray diffraction patterns. On the other hand, Cylindrotheca sp. showed a spectrum similar to that of opal-CT.

Keywords: diatoms, moleculer structure, X-ray diffraction, IR spectroscopy